

Claims

- [c1] 1. A method of operating a refrigeration cycle using an expansion valve and a variable displacement compressor having an electronic capacity control valve, characterized in that during normal operation, the refrigeration cycle is controlled such that refrigerant always has superheat at an outlet of an evaporator, and the refrigeration cycle is periodically operated in oil circulation mode for a predetermined time, the oil circulation mode being a mode in which the refrigeration cycle is controlled such that the superheat of the refrigerant at the outlet of the evaporator is forcibly eliminated by at least one of the electronic capacity control valve of the variable displacement compressor and the expansion valve.
- [c2] 2. The method of operating a refrigeration cycle according to claim 1, characterized in that intervals at which the refrigeration cycle is operated in the oil circulation mode are varied in accordance with a refrigeration load.
- [c3] 3. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable dis-

placement compressor is a constant differential pressure control type in which a differential pressure between discharge and suction pressures thereof is controlled to a constant value by the electronic capacity control valve, the expansion valve is an electronic expansion valve of constant flow rate control type which controls a flow rate of the refrigerant to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to increase the flow rate of the refrigerant.

[c4] 4. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a constant differential pressure control type in which a differential pressure between discharge and suction pressures thereof is controlled to a constant value by the electronic capacity control valve, the expansion valve is an electronic expansion valve of constant flow rate control type which controls a flow rate of the refrigerant to a constant value, and in the oil circulation mode the electronic capacity control valve is set so as to decrease the differential pressure.

[c5] 5. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a constant differential pressure control type in which a differential pressure between discharge and suction pressures thereof is controlled to a

constant value by the electronic capacity control valve, the expansion valve is an electronic expansion valve of constant flow rate control type which controls a flow rate of the refrigerant to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to increase the flow rate of the refrigerant and simultaneously the electronic capacity control valve is set so as to decrease the differential pressure.

[c6] 6. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a constant differential pressure control type in which a differential pressure between discharge and suction pressures thereof is controlled to a constant value by the electronic capacity control valve, the expansion valve is an electronic expansion valve of constant flow rate control type which controls a flow rate of the refrigerant to a constant value, and in the oil circulation mode the electronic capacity control valve is first set so as to increase the differential pressure and then to decrease the differential pressure.

[c7] 7. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic

capacity control valve is constituted by a proportional control valve capable of varying a cross-sectional area of a discharge-side refrigerant passage and a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of the proportional control valve to a constant value, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to decrease the differential pressure thereof.

- [c8] 8. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a proportional control valve capable of varying a cross-sectional area of a discharge-side refrigerant passage and a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of the proportional control valve to a constant value, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a differential pres-

sure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the proportional control valve is set so as to increase the discharge flow rate.

[c9] 9. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a proportional control valve capable of varying a cross-sectional area of a discharge-side refrigerant passage and a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of the proportional control valve to a constant value, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to decrease the differential pressure thereof and simultaneously the proportional control valve is set so as to increase the discharge flow rate.

[c10] 10. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable dis-

placement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a proportional control valve capable of varying a cross-sectional area of a discharge-side refrigerant passage and a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of the proportional control valve to a constant value, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the proportional control valve is first set so as to decrease the discharge flow rate and then to increase the discharge flow rate.

- [c11] 11. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a constant differential pressure valve for controlling a first differential pressure between inlet and outlet sides of a fixed orifice arranged in a discharge-side refrigerant passage and

having a fixed cross-sectional area such that the first differential pressure is constant, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a second differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to decrease the second differential pressure.

- [c12] 12. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a constant differential pressure valve for controlling a first differential pressure between inlet and outlet sides of a fixed orifice arranged in a discharge-side refrigerant passage and having a fixed cross-sectional area such that the first differential pressure is constant, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a second differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the constant differential pressure valve constituting the electronic capacity control valve is set so as to

decrease the first differential pressure.

[c13] 13. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a constant differential pressure valve for controlling a first differential pressure between inlet and outlet sides of a fixed orifice arranged in a discharge-side refrigerant passage and having a fixed cross-sectional area such that the first differential pressure is constant, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a second differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the electronic expansion valve is set so as to decrease the second differential pressure and simultaneously the constant differential pressure valve constituting the electronic capacity control valve is set so as to decrease the first differential pressure.

[c14] 14. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is con-

trolled to a constant value and of which the electronic capacity control valve is constituted by a constant differential pressure valve for controlling a first differential pressure between inlet and outlet sides of a fixed orifice arranged in a discharge-side refrigerant passage and having a fixed cross-sectional area such that the first differential pressure is constant, the expansion valve is an electronic expansion valve of constant differential pressure control type in which a second differential pressure between inlet and outlet sides thereof is controlled to a constant value, and in the oil circulation mode the constant differential pressure valve constituting the electronic capacity control valve is first set so as to increase the first differential pressure and then to decrease the first differential pressure.

- [c15] 15. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a constant differential pressure control type in which a differential pressure between discharge and suction pressures thereof is controlled to a constant value by the electronic capacity control valve, the expansion valve is a normally charged thermostatic expansion valve, and in the oil circulation mode the electronic capacity control valve is first set so as to increase the differential pressure and then to decrease the

differential pressure.

[c16] 16. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a proportional control valve capable of varying a cross-sectional area of a discharge-side refrigerant passage and a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of the proportional control valve to a constant value, the expansion valve is a normally charged thermostatic expansion valve, and in the oil circulation mode the proportional control valve is first set so as to decrease the discharge flow rate and then to increase the discharge flow rate.

[c17] 17. The method of operating a refrigeration cycle according to claim 1, characterized in that the variable displacement compressor is a flow rate control type in which a discharge flow rate of the refrigerant is controlled to a constant value and of which the electronic capacity control valve is constituted by a constant differential pressure valve for controlling a differential pressure between inlet and outlet sides of a fixed orifice arranged in a discharge-side refrigerant passage and hav-

ing a fixed cross-sectional area such that the differential pressure is constant, the expansion valve is a normally charged thermostatic expansion valve, and in the oil circulation mode the constant differential pressure valve is first set so as to increase the differential pressure and then to decrease the differential pressure.

- [c18] 18. A refrigeration cycle using an electronic expansion valve and a variable displacement compressor having an electronic capacity control valve, characterized by comprising:
- a superheat control device for controlling at least one of the electronic capacity control valve of the variable displacement compressor and the electronic expansion valve in a manner such that while refrigerant is controlled so as to always have superheat at an outlet of an evaporator, the superheat of the refrigerant at the outlet of the evaporator is periodically forcibly eliminated for a predetermined time.